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Spatial targeting, synergies and scale: Exploring the criteria of smart practices for siting renewable energy projects

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Abstract: Policies and strategies to develop renewable energy and the rates of successful deployment vary from country to country. Academic literature is rife with examples of recurring problems and malpractice in the implementation of renewable energy projects. We could see each national and sectoral effort as an 'experiment' in the early phase of our attempted transition to a low carbon energy system. What lessons can we learn from a comparative analysis of these experiments? This paper seeks to draw generic lessons not from what has gone wrong but from national case studies that stand out in a best way. Through a European academic network, we have selected and analysed 51 'smart practice' case studies of renewable energy development from 20 countries. We present the outcomes of both qualitative and quantitative analysis of these case studies (smart practice criteria) and discuss a set of generic findings concerning specific types of smart practices and problems of potential transferability of projects to other regions. With regards to policy relevance, the findings can be used for evaluating portfolios of renewable energy projects developed to date and for setting guiding principles for project design, spatial planning and consent by means of cross-national learning and fertilization.

Keywords: renewable energy; smart practice; case studies; energy landscapes; Europe

1. Introduction

Growing awareness of anthropogenic climate change and the exhaustion of easy-to-extract and cheap to refine fossil fuel reserves have led to a growing interest in the development of cleaner and cheaper energy sources. This energy transition is not merely technical or supply-side; it has impacts on all spheres of human society, including on industrial networks, infrastructures, social practices, regulations, symbolic meanings, and landscapes (Smil, 2010). Growing the renewable energy sector has altered landscapes and land use dynamics, brought about new land use conflicts (Calvert and Mabee, 2015; Frantál and Kunc, 2011; Van der Horst and Vermeylen, 2012) and disconnections between policy makers and stakeholders (Warren 2014).

Renewable energy is spatially diffuse and the desire to harness it at scale, creates new productive demands on locations and landscapes that may already struggle to accommodate different interests of development and conservation. Most industrially developed countries have now adopted targets for renewable energy as part of their commitment to reduce greenhouse gas emissions, and are thus looking for methods to accommodate growing numbers of renewable energy facilities on their territory, and to reduce stakeholder conflicts and public opposition arising from these developments (Abdmouleh et al., 2015).

There have been significant differences between countries in the level of successful deployment and the extent of controversies and public opposition (Toke et al., 2008; Marques and Fuinhas, 2012; Darmani et al., 2014). While some countries have already almost exhausted their realizable potential and the on-land space for new developments in some respects (e.g., for large wind parks or large hydro power plants), other countries are far behind, reluctant or just starting out. So there is clearly scope for international comparisons and learning. But learning from comparative analysis is not necessarily straight forward, given that there are often significant national differences in economic, legal-procedural, socio-political and cultural-historic contexts.

Focussing on the siting of (more) renewable energy projects in (already crowded) diverse landscapes, the aim of this paper is to explore what international lessons can be gleaned from specific projects that are nationally perceived to be innovative and successful. More concretely, we seek to synthesise wider lessons from a range of nationally perceived ´best practice´ projects, and examine how can these examples be analysed in order to yield guidance for other countries? It is important to bear in mind, however, that the "wicked problem" of sustainability and the inherent tensions between development and conservation means that it would be naïve and overly simplistic for this study to seek mathematically optimisable solutions or concrete answers with universal validity.

In the theoretical departures, we theorize and critically discuss the nature and principles of smart practice analysis, its advantages over the best practice approach and its methodological limitations. Then we provide a complex definition of smart practice in the planning and siting of renewable energy production systems. In the empirical part, we focus on the following research objectives: (i) Identifying and classifying specific criteria (indicators) of smart practice, (ii) Deriving more generic criteria or factors of smart practice, (iii) Creating a typology of smart practice projects, (iv) Assessing a potential transferability of smart practices to other regional contexts. The presented results have been structured into subchapters reflecting these research objectives. Finaly, we conclude with policy-relevant recommendations.

2. Theoretical departures: From ´best practice´ to ´smart practice´ in renewable energy development

In the context of management, Kerzner (2004, p. 46) defined best practices as 'reusable activities or processes that continuously add value to the deliverables of the projects. Best practices can also increase the likelihood of success of each and every project.' Best practices are not necessarily ideal or perfect, but they represent what has been or is being implemented elsewhere and has been proven to work (Veselý, 2011). The various definitions of 'best practices' show that their rationale is based on not only constant learning, feedback and reflection of what works and why but also, no less important, on what does not work (Stenström and Laine, 2006). The identification of best practices is usually linked to examples of applied innovations and would typically suggest that there is a potential for rapid wider diffusion.

When it comes to the question of how to identify best practice, the literature is somewhat ambiguous (Myers et al., 2004). Bretschneider et al. (2005) argue that a best practice design can be characterised by two conditions. The first is to obtain empirical information on all the relevant cases. The second condition requires 'a complete and accurate statement of the causal relationships linking inputs to outputs', in order to ensure the comparability of cases. It is, however, commonly agreed that both conditions are hard to achieve and that they should only guide the design of the study (Bretschneider et al., 2005; Bardach, 2000; 2004).

This methodological challenge is further exacerbated by a controversy about the meaning of best practice. Bardach (2000; 2004) suggested that the term ´best practices´ is misleading. There is an ontological aspect to this; how can we really know what is the 'best'? And even if at one particular moment in time the number of options are sufficiently limited to help experts reach a strong consensus around what is the least worst option (semantically 'the best' of the lot), how can we know that this label still sticks when conditions, policies, technologies etc. continue to change?

Given that the term 'practice' refers to an activity that is executed by a particular group of practitioners, it can be argued that best practice always depends on the particular context in which a particular practice is situated. A ´smart practice´ may therefore be a more useful concept for academics to explore. Although 'smart' is also a rather vague and popular term in management, it can be distinguished from the 'best' practice by its greater focus on the processes that produce agreeable outcomes.

The task of the researchers is to explore the 'smartness' of a given practice, to verbalize it and evaluate for applicability in the context of the target site (Bardach, 2000, Veselý, 2011). The key task of smart practice analysis should particularly be to identify the 'essential aspects' of a given practice that causally produce the desired effects (without them there would not be any positive effect). It is important to distinguish the essential aspects of a given practice from so called supportive aspects, which may increase the effectiveness or sustainability of a given practice but do not guarantee the valued effects on their own (Veselý, 2011, p. 107).

Barzelay and Campbell (2003, p. 14) have argued that smart practice analysis should seek to identify the causal mechanisms and processes that help to overcome the 'tendency of political, technical, and organizational systems in the public sector to perform unsatisfactorily with respect to evolutionary adaptation.' The idea of evolutionary adaptation already contains within it, firstly, the notions of learning from experience and achieving improvements over time by abandoning practices that have not worked well and the adoption of practices that have proven to be more successful. Secondly, it implies the ability to adjust to dynamic exogenous factors, which reflects the experience that what works well here and now may not work there or tomorrow. Thirdly, it implies that there is value in experimentation, since this creates more opportunities to learn from a wider set of experiences.

Smart practice studies can be found across disciplines. Authors have already depicted smart practices also in renewable energy development, yet mostly with a focus on individual renewable energy production systems and within one or similar regional contexts. For example, Wolsink (2007), He et al. (2016), González et al. (2017) and Frantál et al. (2017) have focused on successful measures in the promotion of either on-shore or off-shore wind farms; Cabraal et al. (1996) and Tsikalakis et al. (2011) highlighted smart practices in solar schemes; and Dolman and Simmonds (2010) examined wave and tidal energy. The criterial of smart practice and negative side-effects of projects in bioenergy, biomass and biogas production have been recently explored by Ciervo and Schmitz (2017 or Martinát et al. (2017). Abdmouleh et al. (2015), Kitzing et al. (2012) and Griffiths (2017) studied best practices concerning national renewable energy policies in general. Thapar et al. (2016), on the other hand, focused more on the perspective of developing countries, identifying innovative practices followed in India which have enabled accelerated renewable energy capacity with minimal financial obligations. Valentine (2013) focuses on wind energy policies applied in Denmark as an example of the gradual best practices; and best practices of micro-hydro power in the case of developing countries were studied by Khennas and Barnett (2000).

Focusing on best and worst practices in designing auctions for renewable energy as one of the supportive schemes, Del Río (2017) argues that best practices of auction design usually involve trade-offs between criteria. Overall, these results suggest that the choice of a specific design element is not a win-win decision and depends on the priorities of the respective government. Proposals of best practices for development of off-grid energy systems in remote communities that might be primarily utilized in developing countries have been presented by Akinyele and Rayudu (2016). Tan et al. (2016) studied best practices in promoting sustainable urbanization in China and they pointed out that different regions (have to) adopt different methods for achieving different outcomes.

Based on the insights of such previous studies, as well as the above mentioned definitions, *smart practice* in the planning and siting of renewable energy production systems, would at least have to (i) effectively produce energy based on renewable sources; (ii) seek to minimise environmental harm in each stage of its production, operation and disposal (life cycle); and (iii) seek to decrease potential conflicts among individual users (or groups of users) of the landscape where it sited, throughout participation, collaboration and planning.

Fulfilling the above defined criteria to a very high standard can be quite challenging, due to various geographic, socioeconomic and cultural conditions of individual sites and communities where the projects are located. Yet, given the need for the energy transition to see renewable energy niches becoming the regime, the transferability of solutions for renewable energy development is very important (Raven et al., 2008). Like in other planning-related practices, there may be a need for some 'sustained effort and imaginative adaptation', but collecting and analysing a rich pool of cases (as we seek to do in this paper), provides opportunities for ideas to be re-applied elsewhere and under somewhat different circumstances (Selman, 2004, p. 388).

3. Methods and data

3.1 Research method and procedure

Inspired by Delphi methods, we deploy a mixed methods characterised by several rounds of expert engagement. We start with a qualitative phase of expert elicitation of national cases of good (smart) practices, followed by a quantitative exploration of recurring characteristics of this collection of smart practice examples, using computer assisted procedures. Delphi methods elicit expert knowledge on the basis of interaction and iteration. Since the 1970s, Delphi methods have become well-established internationally and widely used in a number of policy domains (including energy), often as part of wider scenario process that draws on a range of analytical and deliberative methods (Miles et al, 2016). Delphi methods have expanded and diversified over time, in an effort to recognise that experts with different backgrounds are likely to respond differently (EPA, 2011) and to subsequently deal with the risk of a 'false consensus' (Morgan, 2014). The quality of a Delphi study depends on (i) the selection of participating experts and (ii) the methods and sequence of interaction and iteration; and these two factors are not independent of each other. What makes for a 'good quality' Delphi study is not absolute question, but rather a question of the 'fit for purpose'. For example, a higher level of quality may be required to address specific policy needs (de Löe et al., 2016).

For expert knowledge elicitation, we invited participation of more than 100 experts from 30 countries (covering most EU countries, plus Norway, Switzerland, Serbia, and Israel), working together through the COST Action (see Acknowledgements). The explorative research included the following steps:

(i) National experts were invited to identify what they considered to be 'smart practice' in renewable energy developments in their own country (particularly examples which are highlighted in media, presented in academic publications, etc.). We asked experts to pick one or more case studies, providing basic description of the project (name, location, technology, size, ownership, timeline, impacts) and justifying by what criteria the project should be considered as a smart practice. Altogether, 51 case studies were collected (see part 3.2)

(ii) Meeting of the working group (including the authors of this paper) to discuss what characteristics of case studies to distil. The narrations of all case studies were collectively reviewed and analysed to identify specific characteristics representing criteria of smart practice. A list of criteria (indicators) of smart practice was created, including 23 specific criteria (see part 4.1). We focused primarily on the 'outcome' criteria, although criteria related to the process (such as participatory planning or trust building) were mentioned in the descriptions of the case studies.

(iii) Presenters of national case studies were consulted again to determine which of 23 criteria each case study meets - using a simple binary coding of 1 (project meets the criterion) or 0 (project does not meet the criterion).

(iv) The data and information from the case studies have been coded, categorized and converted into a data matrix usable for statistical analysis. The data were analysed using SPSS version 21, providing basic descriptive statistics, factor analysis (principal component analysis [PCA]), and multiple correspondent analysis [MCA]. The factor analysis is primarily intended for continuous or categorical variables; however, the PCA can be alternatively applied also for binary data or so called dummy variables (see e.g. Kolenikov and Angeles, 2004). The problem of using binary data in PCA may be extraction of too many factors to explain a sufficient percent of variance. Thus, in addition to PCA, we used also MCA to confront results of both methods. The MCA allows summarizing the information when the variables are categorical or binomial. This exploratory technique represents graphically the row and column categories and enlightens their associations. Cluster analysis with MCA variable scores supported our typology of smart practices (based on the results of PCA).

(v) Meeting of the working group (authors of this paper) to discuss the findings of statistical analysis. A typology of smart practice projects was designed based on the interpretation of results of statistical analysis. Types are constructed in order to comprehend, understand and explain complex social realities (Kluge, 2000). The proposed typology consists of 'empirically grounded types' combining empirical analyses and theoretical knowledge of the experts. Potential use of the results and policy implications were discussed and formulated.

3.2 Data set

The created dataset of smart practices includes 51 case studies from 20 European countries (see Fig. 1). The basic characteristics of case studies are presented in Table 1.

Eight case studies are represented by innovative policies, plans, methodologies or tools, including (i) new methodological approach for defining nationally significant heritage areas in respect to wind energy development from Germany; (ii) the 'DECC 2014 Community Energy Strategy' on community co-ownership of large renewable energy projects from the UK; (iii) the law requiring the installation of solar water heaters in residential buildings in Israel; (iv) regional action plan for local renewable energy initiatives from the Netherlands; (v) regional landscape plan and guidelines for renewable energy development from Apulia, Italy; (vi) innovative methodology to evaluate landscape impact of wind turbines based on the 'parametric visibility model' from Andalusia, Spain; (vii) digital map of wind energy potential of Sweden; and (viii) the report on 'Participatory landscape analysis for wind power' from Sweden.

Four case studies are examples of innovative technologies, procedures or projects, which were implemented multiple times at different locations, including (i) the innovative technology of lightning of wind turbines from Germany; (ii) projects of solar panels implemented in noise protection walls around motorways in Germany, Italy and some other countries; (iii) special construction systems for solar panels allowing cultivation and farm mechanization underneath from Italy; and (iv) the project of cultivation of wild flowers and plants as an alternative source for biogas production in Germany.

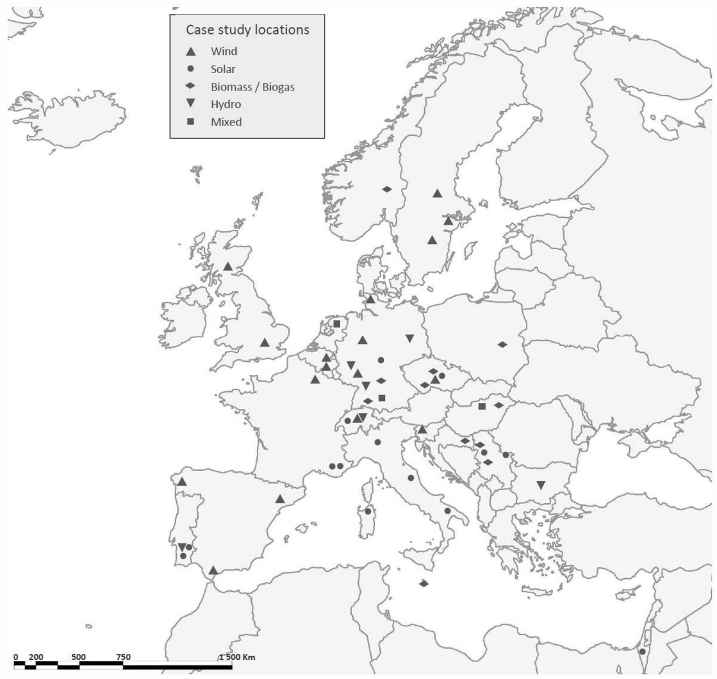

Fig. 1. Location of European smart practice case studies.

Table 1. Basic characteristics of smart practice case studies

Category		Number	[%]
Type	Specific project realized on a particular place	39	76
	Technology or procedure implemented at different locations	4	7
	Policy document, plan, method or tool	8	17
Energy	Wind (onshore)	16	31
	PV (ground-mounted)	7	14
	PV (on roof)	5	10
	Solar-thermal (on roof)	1	2
	Biogas	4	8
	Biomass	6	12
	Hydro (small)	2	4
	Hydro (large)	4	8
	Mixed	6	12
Location	Rural area	29	57
	Urban area	10	20
	No specific location	12	23
In total		**51**	**100**

Source: Author´s survey

Additional 39 case studies are examples of specific projects realized on a particular site. The majority of them are located in rural areas, only a small number is found in urban areas. More than half of projects are located in borderland areas (or inner peripheries at the borders of countries or regions), which can be clearly visible even in the location map. Wind energy constitutes almost one third of all case studies. A quarter of the case studies concerns solar energy (with a majority of ground-mounted and rooftop-mounted photovoltaic systems). One fifth is represented by projects of either or both biomass cultivation and biogas production. Six case studies concern hydropower, including one pumped-storage plant, and five case studies are examples of multifunctional (mixed-energy) projects.

3.3 Methodological limitations

The representativeness of the sample could be questioned because of the uneven representation of the participating countries (more case studies from some countries while no example from few countries). Indeed, the expert response was voluntary and therefore self-selected. If we assume that interest and expertise are strongly correlated, then this selection bias has only minor effect on the quality of our study. Overall, we received at least one case study from 20 countries. The sample does not have to represent all countries, but ideally it would include all the smart and/or innovative examples out-predefined geographic settings.

In fact, the sample may reflect the reality where there are some countries that are leading in their utilization of particular types of renewable energy (e.g. Germany in wind energy, PVs and biomass production, the Czech Republic in biogas and PVs, Switzerland in hydropower, etc.). The continues growth of these countries' renewable energy sector might, however, become more limited because it will be harder for them to find suitable spaces for new developments, and potential conflicts will likely to become more abundant. Such countries are represented by several case studies, which give them the opportunity for cross-national learning. Alternatively, in some countries the renewable energy sector is just developing and early mistakes and recurring problems are encountered. This was evidenced by the answers of some experts who have argued that there are no good practice projects (to follow) in their countries (for example in Slovakia). We are aware that some countries with developed renewable energy sectors are missing in the sample, but we believe that the sample is broad enough (in terms of representation of countries, types of energy and of practice) for the purpose of the analysis.

4. Results

4.1 Specific criteria of smart practice

During the qualitative analysis of the case studies we identified 23 specific criteria by which the case studies can be considered as a smart practice. The description of these criteria and their absolute numbers and relative frequencies (dependent on how much projects meet each specific criterion) are presented in Table 2.

Six specific projects meet 10 or more different criteria of smart practice. These include (1) a photovoltaic power plant constructed around the tailings ponds belonging to a nearby uranium ore mine in Rožná, Czech Republic; (2) solar panels constructed on the roof of an agricultural farm in Moustiers, France, which were a part of a local social enterprise project; (3) a local biomass heating system in a small village Tiszatarjan, Hungary; (4) Energy farm Eidsalm in Norway; (5) a small community wind farm in Vents d'Houyet, Belgium; and (6) a hydroelectric power plant of Alqueva, Portugal.

4.2 Generic criteria of smart practice

In order to explore the structure of relations among specific characteristics (criteria) of smart practice and to find out if they can be divided into groups representing more generic criteria, we applied both the Principal Component Analysis (PCA) and Multiple Correspondent Analysis (MCA). The results of PCA are presented in Table 3. The presented results were generated using the Varimax rotation solution with the measures of the Kaiser-Meyer-Olkin test of sampling adequacy (KMO=0.596) and Barlett's test of sphericity ($p < 0.001$) confirming a relative appropriateness of the selected variables for the factor analysis.

Table 2. Criteria of smart practice projects: absolute and relative frequencies

Criterion	Description	Abs.	Rel. [%]
Rural area	Located in a rural area	29	9.2
Visual impact	Reduces visual impact	26	8.3
Local benefits	Provides economic benefits for local people/community	24	7.6
Border periphery	Located in a border or peripheral area	22	7.0
Low population	Located in areas with low population density	21	6.7
Pilot project	Represents a pilot or experimental project	20	6.4
Local demand	Meets the local demand for energy	16	5.1
Deconcentration	Provides spatial deconcentration of impacts	16	5.1
Land use synergy	Allows multifunctional use of land	15	4.8
Environmental synergy	Compatible with environment, using local sources	14	4.4
No conflict of use	Located on land without other (significant) use	13	4.1
Technological innovation	Represents technological improvement or innovation	13	4.1
Small scale	Consists of small size and/or small number of units	12	3.8
New landmark	Creates a new visual landmark	12	3.8
Co-benefits	Provides by-products and/or co-benefits	10	3.2
Reversibility	Easy removal of technology, thus restoring the area	9	2.9
Demonstration effect	Serves for demonstration and public education	9	2.9
Regulation function	Provides some eco-system regulation function	9	2.9
Heritage synergy	Is compatible with cultural heritage objects	7	2.2
Degraded land	Uses environmentally degraded land (brownfields)	5	1.6
Infrastructure synergy	Utilizes existing infrastructure	5	1.6
Improving stigmatized land	Improves image of environmentally stigmatized land	4	1.3
Energy region	Located in an area already used for energy production	4	1.3
In total		**315**	**100**

Source: Author´s survey

The total variance explained by eight extracted components is 75%. The first two components, each of which explains nearly 15% of variance, include variables or criteria related to the location and geographical context of projects. These components represent the spatial targeting of projects (either to peripheral rural areas or kind of degraded (post-)industrial areas). The third extracted component, including the criteria of scale and spatial de-concentration, explains 10% of the variance. The other five components represent different kinds of 'synergies criteria' (infrastructural, economic, environmental, multiple land-use and heritage) provided by projects. Some of the variables (specific criteria) correlate relatively strongly with more than one factor, which is most visible in the case of 'visual impact', which correlates with five factors – most strongly with the ´small scale and de-concentration´ and 'infrastructure synergy'. With regards to these results and the relative frequencies (Tab. 2), the visual impact can be considered the key criterion of smart practice projects. It is logical that small projects minimize possible negative environmental impacts, however, these projects contribute less (in terms of energy production) to overall development.

The use of MCA gives similar information. According to their eigenvalue, we took into account the top seven dimensions. The position of the variables in the vector plan based on dimensions 1 and 2 (Fig. 2), which summarizes 29% of the inertia, highlighting a gradient concerning the visual impact. This impact should be mitigated on the left side and matters less at the right side. The analysis of the diagonals allows opposing 'easy reversibility' and 'no conflict of use' (quadrant 3) to 'co-benefits' and 'environmental synergy' (quadrant 1); 'low population', 'rural area', 'border region', 'demonstration effect', 'new landmark' (quadrant 4) to 'heritage synergy' and 'technological information' (quadrant 2). While the variable 'infrastructure synergy' leads the negative direction of the dimension 1, 'energy region', ‘degraded land’ and ‘improvement of image’ influence strongly the dimension 2. Due partially to the low number of occurrence in the sample, ‘energy region’ is isolated in the fourth quadrant.

The dimension 3 opposes ‘de-concentration’ and ‘small scale’ to ‘regulation function’ and ‘degraded land’, while the dimension 4 puts the light on a group of variables composed by ‘heritage synergy’, ‘land use synergy’ and ‘technological innovation’, which is opposed to ‘local energy demand’. The dimension 5 to 7 do not inform about new group or opposition of variables.

Table 3. The extracted components of smart practice criteria using PCA

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	Spatial targeting - Rural	Spatial targeting - Industrial	Small scale and deconcentration	Infrastructure synergy	Local economic benefits	Environmental synergy	Land use synergy via innovation	Heritage synergy and education
Border periphery	**0.85**							
Rural area	**0.84**							
Low population	**0.83**							
Demonstration effect	0.57							0.54
Improving stigmatized		**0.85**						
Degraded land		**0.83**						
Energy region		**0.74**						
Small scale			**0.91**					
Deconcentration			**0.85**					
Reversibility				**0.79**				
No conflict of use		0.41		**0.76**				
Infrastructure synergy	- 0.42			**0.60**				
Local benefits					**0.83**			
Local demand					**0.81**			
Visual impact		- 0.32	**0.36**	**0.36**	- 0.30	- 0.34		
Environmental synergy						**0.87**		
Regulation function			- 0.36			**0.62**		
Co-benefits					0.33	**0.51**		0.39
Technological innovation							**0.76**	
Pilot project			- 0.33		0.33		**0.60**	
Land use synergy				0.34			**0.57**	0.45
Heritage synergy					- 0.33			**0.64**
New landmark		0.38				- 0.40		**0.60**

Notes: Principal Component Analysis, rotation method Varimax with Kaiser Normalization. Factor loadings lower than 0.3 were excluded. Source: own calculation. Source: Author´s survey and calculation

The clustering of the variables constructed on the seven first dimensions suggests five or six clusters (Fig. 3). The first separation isolates the smart practices that create an energy region and improve stigmatized or degraded land. A second isolated group encompasses the smart practices that privilege infrastructure synergy and easy reversibility avoiding conflict use. A third group of smart practice is based on land use and heritage synergies including technological innovation and the reduction of visual impacts. The fourth group targets low population areas like rural and border regions. In these locations, there are also opportunities for renewable energy plant to be seen as new landmarks and to develop some pilot or demonstration actions. The fifth group can be divided into two branches. One is targeting socioeconomic benefits and local energy demand, typically associated with smaller scale projects that are spatially de-concentrated. The second branch is aiming at environmental synergies and co-benefits.

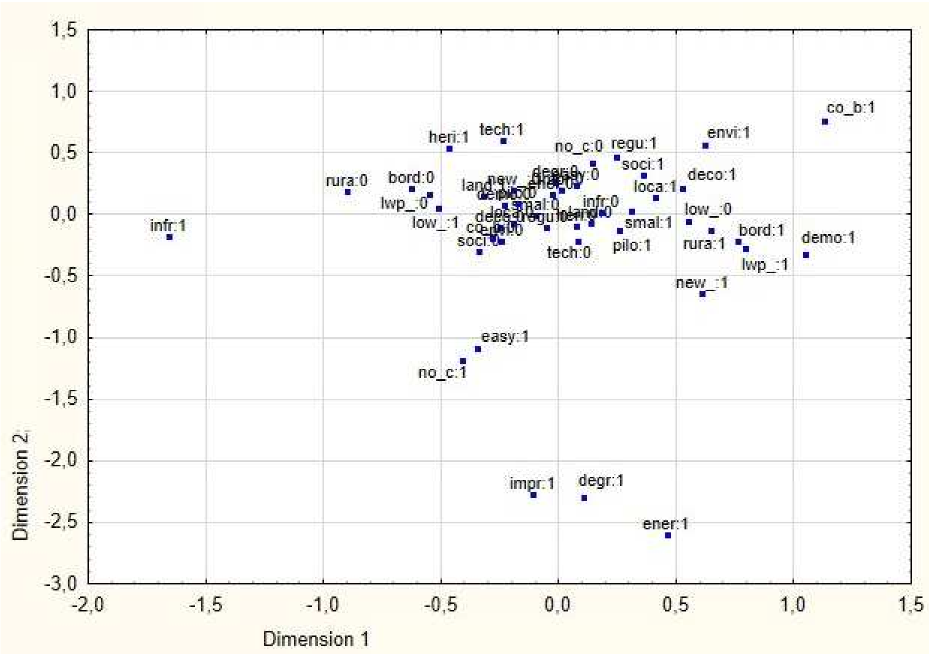

Fig. 2. The result of Multiple Correspondent Analysis

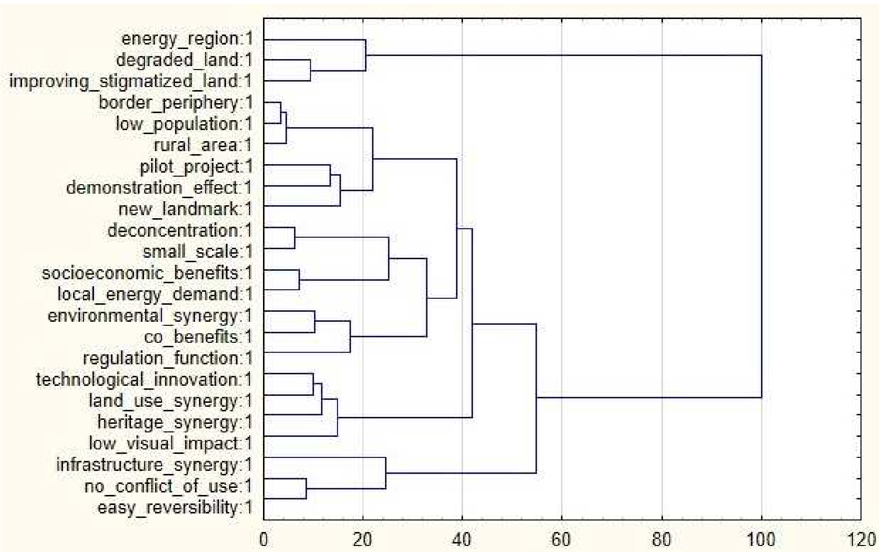

Fig. 3. The groupings of smart practice criteria based on cluster analysis (Ward´s method)

4.3 Typology of smart practices

Synthesising the above results, we propose a generic typology of smart practice projects, consisting of two main groups and several sub-types. The first group consists of smart practices which are characterized by spatial targeting of projects to specific geographical areas in order to minimize potential land use and social conflicts. In this group, projects are typically targeted towards either low population, peripheral and economically under-developed rural areas or towards (post-)industrial and (post-)mining areas, which are often environmentally degraded. The second group includes projects which provide some kind of synergies (with the local environment, cultural heritage, local economic development and multiple land uses).

Table 4. Typology of smart practices

Type	Characterization	Examples
1. Spatial targeting		
1.1 Rural peripheral area *(low-cost land)*	- Low populated, less favoured, economically deprived rural areas - Borderland or inner peripheries - Landscape of no special value, no environmental protection - Motivation effect of economic benefits for local communities	- PV plant Sol Poente (Mértola, Portugal) - Wind farm Pavlov (Czech Republic)
1.2 (post-)Industrial or (post-)mining area *(negative cost land)*	- Using environmentally degraded or derelict land (brownfields) - Improving the image of environmentally stigmatized areas - Concentration of externalities (already affected energy regions)	- PVs at the uranium ore mine site (Rožná, Czech Republic) - Wind turbines on a waste dump hill (Gelsenkirchen, Germany) - Eco-remediation of degraded land by growing energy crops (Mitrovica, Serbia)
2. Synergy providing		
2.1 Infrastructure synergy	- Synergy with existing infrastructure (e.g., road and rail networks) - No conflict of use - Easy reversibility - Reducing visual and other impacts	- PVs on noise protection walls along highways (Germany) - Wind parks along railways (Gingelom Greensky, Belgium) - Floating solar farms on lakes (Walton-on-Thames, UK)
2.2 Local economy synergy	- Increasing local energy independence - Direct economic profits for local people - Stimulating public participation and shareholding	- Biogas plant with central heating system (Kněžice, Czech Republic) - Wind turbines owned by children (Vents d'Houyet, Belgium)
2.3 Environmental synergy	- Compatible with the environment - Using local resources/wastes - Providing regulation functions - Generating co-benefits or by-products	- energetic utilization of fruit tree cuttings (Baden-Württemberg, Germany) - bioenergy feed stock production from wetland management (Hungary)
2.4 Land use synergy via technological innovation	- Enabling multifunctional use of land - Promoting technological innovations - Pilot or experimental projects (practice as a laboratory)	- Agrovoltaico project - food and energy production (Italy) - Innovative lighting of wind turbines (Ockholm-Langenhorn, Germany)
2.5 Heritage synergy and education	- Synergy with historical-cultural heritage - Energy tourism (information centres, watching towers, eco-trails, etc.) - Demonstration and education effect	- Sotavento experimental wind farm (Lugo, Spain) - Renovated old water mills (Germany) - Energy farm Eidsalm (Norway)

Source: Author´s conceptualization

In reality, most of the projects meet several criteria of smart practice and thus fit into several categories (types) simultaneously. Part of the differentiation between the smart practice types of ‘targeting’ and ‘synergies’ could be understood in terms of relative scale; spatial targeting relates to broader geographical areas which can be identified at a strategic, national level (e.g. through a GIS analysis of national digital databases), whereas synergies are likely to require more locally specific knowledge and joined-up thinking between different sectoral agencies.

5. Discussion

Whilst there is great variety in the sample of projects and policies put forward by participating experts as ‘best’ practice examples in specific countries, our analysis has revealed that the generic smart practices behind this diverse sample can be boiled down to two types of spatial targeting and five types of synergies.

There are various ways in which the findings of this study could potentially be used for international and comparative learning purposes. But it is important to make a very clear distinction between the generic typology and concrete examples. This paper does not seek to provide advice at the concrete project level, and indeed academics must be careful not to uncritically extrapolate and over-extend practical approaches branded as smart practice. The term ‘smart practice’ has been subjected to academic critique, especially if and when policy makers use it (Bulkeley, 2006; Valentine, 2013). It has been argued that the nature of projects, and uniqueness of local political-economic conditions, challenges the transferability potential of smart practices of renewable energy siting (e.g. Garcia, 2011). In other words, concrete examples of national good practice cannot be transferred across or even within national borders without caution and critical thinking for reasons of context and scale. Context is perhaps self-explanatory; many synergies are highly location and context specific. Scale can play out in different ways.

For example, small scale deployments constitute the easier way to reduce both landscape impacts and concentration, being more acceptable for both residents (e.g. Devine-Wright, 2005) and tourists (e.g. Frantal and Kunc, 2010). The reterritorialization process taking place in Belgium (‘one wind turbine, one village’) is a striking example. However, small-scale projects have a limited and often insufficient outputs to achieve longer-term national targets for emission reduction.

Many renewable energy projects implement ab initio plans for their use as educational centres and exhibition venues (e.g., Sotavento wind farm in Spain), they become part of nature trails (Kotka, Finland); some wind turbines serve as observation towers (e.g., Lichtenegg, Austria; Holtriem, Germany or Vancouver, Canada), with the aim of utilizing their tourist potential and to improve the awareness and image of renewable energy. For some municipalities, wind turbines or solar plants have become icons which go toward creating their place brand. These kinds of projects can be considered examples of the process of embracing visibility of energy facilities not as a problem but as an asset in contemporary place competition. There is a question of cumulative effects and possible thresholds; how many local projects are required to give the local area a positive place brand and (when) does the increase in project numbers result in a negative effect on the overall place image.

It is also a question of how big is the potential of energy tourism and how long it can work (Frantál and Urbánková, 2017). One thing that energy tourism certainly has in its favour is the novelty factor (Bello and Etzel, 1985), as it can attract people who want to spend time away from the usual places, to see and to do something different. Unlike industrial heritage sites representing ‘landscapes of nostalgia’ (Halewood and Hannam, 2001), new energy tourism sites represent authentic contemporaneity, or even the landscapes of a possible future, as we can assume further spatial diffusion of wind turbines, solar panels, and other renewable energy technologies in years to come (Frantál and Urbánková, 2017). It is not likely that every new project will become a tourist attraction and the attractiveness of energy facilities for tourists will depend on scale and time (size, number and spatial diffusion in specific countries).

Finally, with regarding scale, it is useful to reflect on the potential transferability or replicability of the best practice projects from our sample that have been initiated and managed by 'experts' and were fully financed or co-financed by EU funds. The demonstration and educational effect of early, unique and high-profile projects are easy to highlight but only time will tell if such projects can be truly transferable, scalable or economically sustainable.

Another, and wider, question that arises with the selection of smart practice case studies by so many different national experts, is whether or not these cases are recognised in other countries as being something special. An example for that is the ”Agrovoltaico project” from Italy. This smart practice includes a special construction system of solar panels allowing cultivation of land and farm mechanization underneath the construction; Yet, few non-Italian experts commented that they have seen similar projects in their country but did not rate it high enough to put forward as an example of good or best practice. The inclusive approach to national expert elicitation we followed in this paper has meant we could not filter-out such projects in advance. This limitation nevertheless did not appear to misguide our identification of generic types of smart practice.

6. Conclusions and policy implications

One of the key challenges in the transition to a low carbon society is to find how various renewable energy systems can be deployed in diverse, crowded and ever changing landscapes, in such ways that would allow us to produce a lot more clean energy without compromise much other things we value. The purpose of our study was to identify international smart practice in 'fitting' renewable energy installations into the landscape, with a specific focus on the outcome (rather than the planning/permitting process). In order to synthesise generic principles from a range of individual case study projects across Europe, we deployed a mixed methods approach that included both expert elicitation and statistical analysis.

Based on the 51 smart practice case studies submitted to us by national experts from 20 countries, we were able to identify a generic typology of smart practices (valid across different technologies and landscapes), consisting of two types of spatial targeting and five types of project synergies. The diversity of countries and projects included in our study and the results from the statistical analysis are sufficient to posit that our findings are relevant for many regions beyond Europe. Even for (future) renewables mega-projects in uninhabited areas such as off-shore windfarms and desert solar farms, it can be argued that this generic typology of smart practices can help to add value and create synergies with other economic or environmental objectives.

With regard to policy relevance, our findings could be utilised in a number of ways, from setting guiding principles for project design, spatial planning and consent (for countries that are still in the process of developing these) to evaluating the portfolio of renewable energy projects developed to date (for countries that are already forging ahead with renewables). Such evaluations may yield insights into the extent to which a national (sub) sector has progressed faster or slower when adopting or ignoring these forms of smart practice (i.e. the value of smart practice adoption), whilst subsequent international cross-comparisons can yield insights into the extent to which different borders have been permeable to lessons learned by early adopters (i.e. the extent of international policy learning in specific countries). The methods deployed in this paper can provide a basis for such international comparisons.

With regard to ex-post evaluation, it is furthermore important for future studies to recognize that the more renewables a country has installed, the more difficult it becomes to finding 'easy' locations or 'win-win' configurations that are still available for a new project.

As a consequence, novel and more specific forms of targeting may need to be developed and new and more contextually specific opportunities for synergy may need to be identified. Since smart practice implies learning by doing (and by implication, learning by making mistakes), and since our typology is conceptually independent of the extent of technology adoption, there is potential scope for this paper to inform a more detailed sectoral analysis of policy learning, adaptive governance and socio-technical innovation.

Beside technological innovation, there are still progresses to be made in planning and governance to enable the renewable energy development. The result of this research is a first step to encourage international comparison on these issues, which burden the energy transition. The analysis consolidates that visibility is a crucial issue all over Europe but found that several solutions exist and could be elaborate to reduce the visual impact or to balance positively the presence of these new landmarks, for instance by giving a sense of these landmarks for locals. This analysis of smart practices across Europe points out some spatial targets, where renewable energy could become an asset for the development and the brand of the region. It is especially the case of remote rural areas and, even more interesting, of undergoing conversion mining or industrial regions. Authorities should list these areas and could foster there suitable renewable energy developments. This international collaboration underlines also the question of transferability that should not be only analysed from a national point of view but also at different scales due to the diversity of spatial and cultural contexts.

The importance of the synergies in good practice requires a more trans-sectoral approach in developing policy instruments. Besides targeting the aims of own sector (i.e. energy, environment protection, socio-economic restructuring, spatial development), policy instruments need to achieve positive impacts in other sectors, too. Such policy instruments should be designed a way that minimize potential negative consequences for a local landscape or society. It means that even copying of particular smart practice in a new context does not necessarily lead a success that might be perceived diversely by different groups of actors. However, the results of the analyses above might be relevant for the decision-makers and landscape planners.

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